Morphological Based Grain Comparison of Three Rice Grain Variety

Cyril L. Macalalad, Edwin R. Arboleda, Adonis A. Andilab and Rhowel M. Dellosa

Abstract— In the Philippines, rice grains have their distinct characteristics from each other variety in terms of quality and on how they plant. The quality and variety of different rice grains is usually determined by visual inspection and pure instincts, which is subjective, laborious, and prone to error. Due to this errors, many consumers were deceived by the retailers in buying pure quality rice. In result, a formulation of an alternative method with the help of the current technology to determine the different rice variety is conducted. This research was conducted with the objective of developing an appropriate computer routine algorithm that can characterize rice grains of different origins in different parts of the Philippines. Morphological analyses through image processing techniques were employed to automatically classify and determine the ranges of the parameters of the rice grain samples according to their variety. Important rice grain features based in morphology such as area of the grain, perimeter, equivalent diameter and percentage of roundness from 60 training images and 20 testing images were gathered and evaluated. Fuzzy Logic technique was conducted to classify the rice grain as well as the K Nearest Neighbor (KNN) that was employed to automatically categorize the variety of the rice grains. In conclusion, the results of this study have revealed that imaging technique with the aid of artificial intelligence could be used as an effective method to classify rice grain characteristics.

Index Terms— Comparison, Fuzzification, Fuzzy Logic, Image Processing, MatLab, Morphological Features Rice Grain Varities

1 INTRODUCTION

Rice is one of the most important cereal grain crops in the Philippines [1]. At present, rice is the majority necessity of every Filipinos to make their meal complete. Rice has the most demand in marketing both domestic and foreign. The reason behind this is that agricultural industry is one of the oldest and most widespread industries in the world [2]. Traditionally quality of food products is defined from its physical and chemical characteristics by human sensory panel. Physical parameter includes grain size and shape, moisture content, chalkiness, whiteness, milling degree and bulk density [3]. Rice productions are used for domestic consumption.

Rice constitutes the world’s principal source of food, being the basic grain for the planet’s largest population. For tropical Asians it is the staple food and is the major source of dietary energy and protein. In Southeast Asia alone, rice is the staple food for 80% of the population [4].

In this paper, three rice grains were considered which are glutinous rice, Sinandomeng rice and Maharlika rice which have the highest demand on the Philippine market [3]. Glutinous rice (Oryza sativa var. glutinosa; also called sticky rice, sweet rice or waxy rice) is a type of rice grown mainly in Southeast and East Asia and the eastern parts of South Asia, which has opaque grains, very low amyllose content, and is especially sticky when cooked. It is called glutinous in the sense of being glue-like or sticky, and not in the sense of containing gluten. While often called “sticky rice”, it differs from non-glutinous strains of japonica rice which also become sticky to some degree when cooked. There are numerous cultivars of glutinous rice, which include japonica, indica, and tropical japonica strains [4]. On the otherhand, Sinandomeng rice is the traditional favorite of every Filipino family. It has 3 types which are the “special,” fancy and ‘regular’. The fancy ‘Sinandomeng’ rice is also called as “laon” meaning ‘old rice’. When cooked, the rice grain becomes fairly soft and ‘maalsa’, Its grains become soft and smooth [5]. Furthermore, Maharlika rice is a variety of rice that is slightly sticky but tender when cooked. This variety of rice have a long grain, its color is almost white as pearl and its texture is smooth. According to specialist, this variety of rice is good for household consumption [6].

According to Jyoti Gupta, rice quality inspection by humans (relying upon the naked eye) is neither objective nor efficient. Error creep in sometimes due to inexperience or the inspection may be deliberately shifted out of sympathy for the producers. In view of this, automated rice quality inspection using computer vision is desirable to perform fast and objective quality measurement [7].

In this research, an imaging technique was employed to classify the above three variety of rice harvested in the Philippines. This system is supposed to have many advantages over the traditional ones due to its effectiveness, non-subjectivity, and efficiency. This research was aimed at developing an appropriate computer routine algorithm that can extract morphological (shape and size) features of rice grain varieties using an imaging technique and be classified
using the fuzzy logic algorithm and KNN classification technique.

2 Research Methods
The proposed project will be classified in such steps using morphological approach with the aid of MatLab software tools specially the fuzzy logic tool and KNN classifier. The image will be captured and will be pre-processed and then be segmented which will be use to extract the morphological features of the image such as the area, equivalent diameter, perimeter and roundness. After the results gathered, the ranges of each feature will be fed in fuzzy logic algorithm to display the result in organized manner and be compared on the KNN classification method.

2.1 Rice Grains
The sample rice grains that were used in the project were from a rice retailer in Indang, Cavite. These sample grains were representatives of three famous variety of rice in the Philippines. These grains were glutinous, Maharlika at Sinandemong rice which have their own unique characteristics. The images were captured using an ASUS Zenfone 3 Max which have 13 Megapixel Camera and stored for processing.

2.2 Image Acquisition
The images of the rice grain samples were taken by placing the samples on a white background. The camera set at 1.4x zoom was held in a position normal to the plane of the rice grains at a distance of 6 inches directly over the plane of the sample. The rice grains samples were evenly spread to deliberately avoid samples touching each other for the bean segmentation become easier and thus improving the accuracy of the morphology features by less errors. In this work, a total of 180 rice grain samples were used in the process, 60 samples for each different rice grain variety.

2.3 Image Processing
Image processing was done through the aid of the MatLab (version R2012a) software with its image processing toolbox and vislabels function. The functions were used to develop a computer routine algorithm to pre-process and extract features of rice grain sample images. After the images of the rice grains were pre-processed, features such morphological characters were extracted for classification [8-10]. The ranges of these 4 features were tabulated and used for the ranges on the Fuzzy Logic Classifier using the Mamdani interference method. Furthermore, K Nearest Neighbor (KNN) was used to classify based on rice grain features extracted from the images. K nearest neighbor algorithm was used since it is an algorithm which uses non-parametric approach to classify the signal into different classes. The answer is based upon the number of votes from its neighbors which is one of the reasons it is called as KNN.

2.4 Image Segmentation
Segmentation is the process of partitioning a digital image into multiple segments (sets of pixels, also known as super pixels) [11]. The goal of segmentation is to simplify and/or change the representation of an image into something that is more meaningful and easier to analyze. Image segmentation is typically used to locate objects and boundaries (lines, curves, etc.) in images. More precisely, image segmentation is the process of assigning a label to every pixel in an image such that pixels with the same label share certain visual characteristics. In this research, image segmentation was used to determine the area, perimeter, diameter and the roundness of every variety of rice grain in order to gather data for comparison.

2.5 Fuzzy Logic Classifier
Fuzzy logic is a theory which relates to classes of objects with unsharp boundaries in which membership is a matter of degree. In this perspective, fuzzy logic in its narrow sense is a branch of FL. Even in its more narrow definition, fuzzy logic differs both in concept and substance from traditional multivalued logical systems. In this project fuzzy logic was used to classify the three different varieties of rice grain. The ranges used in the project were from the data gathered by the morphological approach on the rice grain images.

2.6 K Nearest Neighbor Classifier
KNN is a method which is used for classifying objects based on closest training examples in the feature space. KNN is the most basic type of instance-based learning or lazy learning. It assumes all instances are points in n-dimensional space. A distance measure is needed to determine the “closeness” of instances. KNN classifies an instance by finding its nearest neighbors and picking the most popular class among the neighbors. In KNN, the training samples are mainly described by n-dimensional numeric attributes. The training samples are stored in an n-dimensional space. When a test sample (unknown class label) is given, k-nearest neighbor classifier starts searching the ‘k’ training samples which are closest to the unknown sample or test sample. Closeness is mainly defined in terms of Euclidean distance. The Euclidean distance between two points P and Q i.e. P (p1, p2, pn) and Q (q1, q2, qn) is defined by the following equation:

\[ d(P, Q) = \sum_{i=1}^{n}(Pi – Qi)^2 \]

In order to obtain the KNN algorithm, the researcher gathers sample dataset of columns and rows and were named in which the columns are the input vector and the output vector was separated in another column. Then using the Euclidean distance equation, the proponents find the distances between every sample and decides a random value of K which is the no. of nearest neighbors. After determining K, the classifier will determine the class and shows the output values based on the number of neighbors the researcher sets [13].

2.7 Classification Model
There are three main steps in images classification model namely feature extraction from images, getting data sets and classification of the gathered data sets. As shown in Figure 1, rice grain varieties were analyzed using morphology in which the area, perimeter, diameter and the roundness of the image were determined. After having the data for the four morphological features, it is then fed to the KNN classifier and
the output was represented by the three rice variety, Glutinous Rice, Maharlika Rice, and Sinandomeng Rice.

Fig. 1 Representation of Features
Ranges were gathered and tabulated from the results on the morphological approach of the image processing. The table below shows the ranges of each variety on the four features gathered from the morphological analysis of the rice grain images.

<table>
<thead>
<tr>
<th>Rice Grain</th>
<th>Variety</th>
<th>Morphological Features</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Area</td>
</tr>
<tr>
<td>Glutinous Rice</td>
<td>250-650</td>
<td>18-28</td>
</tr>
<tr>
<td>Maharlika Rice</td>
<td>230 to 930</td>
<td>15 to 35</td>
</tr>
<tr>
<td>Sinandomeng Rice</td>
<td>400 to 900</td>
<td>20 to 40</td>
</tr>
</tbody>
</table>

3 RESULT AND ANALYSIS

Results for the fuzzy logic and K Nearest Neighbor Classification were discussed below. The images used for glutinous rice, Maharlika rice and Sinandomeng rice were shown below and its corresponding filled images in black and white. The sample images below for training data that were gathered separately and tested accordingly to have a comparison or neighbor in KNN morphological analysis.

3.1 Morphological Features Extraction
Morphology refers to shape and size of an object. Four morphological features namely: area, perimeter, equivalent diameter and roundness percentage of each data samples were calculated from binary images and their average and range values were taken for classification.

In Figure 2 and 3 objects can be identified as rice grain by setting the size range. In order to determine the size and disable the noise the researcher used the command bwlabel to irradiate the noise and the rice grains are only the ones labeled. After the grains are labeled, the parameters for the rice grain were gathered using the command, “g = regionprops(z, ‘Area’, ‘Perimeter’, ‘EquivDiameter’);”. The morphological features ranges for the different varieties are shown in Table 1 that was calculated from binary images.

3.2 Fuzzification
A total of 27 rules where set for the classification of the rice grain variety that satisfies the morphological data gathered. The results of the fuzzy logic classifier is presented below accordingly.

3.3 Classification Using Morphology Features in K Nearest Neighbor
Classification is the process of grouping objects having the same characteristics and features [14]. In this experimental setup, four morphological features were used: area, perimeter, equivalent diameter, and roundness percentage. Testing data is used to provide an independent measure of the proposed model’s performance during and after training. In the training phase, 60 samples were used with 20 samples in testing phase. The concept of K-Nearest Neighbor is similar with the closest coordinate scheme of [24] where in it also utilized Euclidean distance to solve the closest points.
Table 2 presented above shows the result of the KNN classification of the three rice grain varieties namely: Glutinous, Maharlika and Sinandomeng rice. The proposed KNN classifier have a good accuracy percentage in classifying the glutinous rice variety, for k=1 to k=10 the range of error is from 10 to 13 errors out of 60 samples which results for obtaining 83.33% rate. The morphological features of the maharlika and sinandomeng are overlapping thus they are very close neighbors as shown in Table 2. Given with enough and good accuracy rate, the results show that there is a high probability in classifying rice grain variety using KNN classifier specially when using a K of 1 and 2. The k=1 yields the highest accuracy rate on the right classification of the rice grains aside from k=2 and k=4. Thus, the features of a single grain compare to its neighbor will yield the same features of the same variety together with when the value of k is equal to 1.

4 Conclusion
The research paper introduces two methods in classifying rice grain variety which are the Fuzzy Logic Classification Method and through K nearest neighbor. The computer can classify the three varieties of rice grains presented in this study which is the glutinous rice, Maharlika rice and Sinandomeng rice via grain images captured from the android cameras or scanners. Ranges of four morphological features such as area, perimeter, diameter and roundness were gathered and extracted and processed to form the input vector of the KNN and of the Fuzzy logic. Experimental result indicates that the algorithm in both methods is workable with accuracy of about 73 percent based on the KNN classifier on three rice grain variety. Furthermore, results show that there is an accuracy rate of 80 percent in the fuzzy logic classifier. Based on the given results, it can be said that the two methods presented can be used efficiently in classifying the rice grain variety in order to protect the consumers in the Philippines.

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